SN 10/ 797,518

REMARKS

Applicant acknowledges the First Action on the merits mailed 27 DEC. 2005, and requests reconsideration of the application, as amended. The claims have been amended to more precisely define the type of motor to which the present application is directed. Specification page 17 has been amended to insert, after "magnetic shunt" the term "flow path element" which is synonymous but perhaps more familiar to the American reader. This provides an antecedent for use of the same term in the claims, as amended.

Responsive to Paragraph 1 of the Action, claim 14 has been amended to make clear that the "adjacent magnet" which performs the flux injection is <u>already present</u> in the motor structure, so that the step of "injecting an additional magnetic flux" <u>does not</u> imply inserting any additional magnet into the rotor. Reconsideration, of the withdrawal of claims 14-19 from consideration, is solicited. Claim 14 and its dependent claims merely recite <u>how</u> the magnetic structural elements <u>perform functions</u> during motor operation. Claims 1-13 and 14-19 rely upon the same motor structure, so it is not understood how the Office can contend that the subject-matter(s) of the two groups of claims are differently classified.

Responsive to Paragraph 2 of the Action, claim 13 has been clarified by spelling out an abbreviation. In some multi-pole motor structures, electrical degrees are greater (e.g. double) the mechanical degrees. See spec. page 10, 3rd line from bottom. Support for claim 13 is found at page 13, paragraph 4.

BACKGROUND:

Motors with reduced cogging torque have been researched by Prof. Silverio Bolognani, of the University of Padua in Italy, and his colleague Mr. Nicola Bianchi; see their article in the SEP-OCT.

2002 IEEE Transactions on Industry Applications, Vol. 38, No. 5, pp. 1259-1265. Motors in which the rotor is formed with internal Permanent Magnets are designated with the shorthand acronym **iPM**. These are further sub-categorized into types **iPMT** and **iPMR**, depending upon whether the permanent magnets create a magnetic flux in the Tangential direction (type iPMT) or create a magnetic flux in the Radial direction (type iPMR). The cited SAKAI reference discloses a type iPMT motor, while the present claims are directed to a type iPMR motor.

SAKAI+/TOSHIBA (USP 6,342,745) discloses, in FIGS. 17-18, that its permanent magnets generate magnetic flux (designated mb) in the **tangential** direction, as described in columns 26-27 of the patent. A severe disadvantage of the SAKAI structure **is that** the magnets 6 are substantially short-circuited (magnetically speaking) by the magnetic yoke, which means that one needs lots of magnetic material and can generate only relatively small magnetic flux in the air gap.

By contrast, the present invention is directed not to a type iPMT motor, but rather to a type iPMR motor in which the permanent magnets (e.g. magnet 262 shown in FIG. 5) generate a **radial** magnetic flux (as shown in present FIG. 17) rather than a tangential flux.

One advantage of the presently claimed structure is that there is less magnetic short-circuiting within the rotor, so that the "useful" magnetic flux in the air gap is greater, and one can "get by" with less magnetic material, making the motor less expensive than a tangential-flux motor with the same performance would be.

Preferably, the rotor of the present invention is configured to generate a sinusoidal flux distribution in the air gap. If such a motor is made with 3 phases, it can generate, using an encoder, a 3-phase sinusoidal voltage. The combination of **sinusoidal** distribution

of magnetic flux in the air gap and the sinusoidal three-phase voltage results in an optimally even (i.e. non-cogged) torque; see page 13. SAKAI teaches away from such a structure.

A disadvantage of taking the radial-flux alternative is that a less-than-ideal distribution of the magnetic flux density can occur. This is shown in FIGS. 11-14. The present disclosure thus teaches how, in a type iPMR motor, one can achieve a better distribution of the magnetic flux density in the air gap.

In order to define the difference between a type iPMT motor and a type iPMR motor, main apparatus claim 1 and main method claim 14 have been amended to recite "said permanent magnet having two poles, one pole thereof facing the adjacent pole shoe and defining a pole shoe boundary, and the other pole thereof facing the yoke and defining a yoke boundary."

ART REJECTION

From the foregoing explanation, it will be apparent that SAKAI is light-years away from the structure recited in the present claims, and provides no suggestion or teaching on how to improve the distribution of magnetic flux in a radial-flux type internal rotor motor. Generally speaking, only in the rarest instances would a type iPMT structure suggest what to do in a type iPMR structure, or vice versa. Rather, each of the iPMT and iPMR structural types had its particular advantages and disadvantages, and "never the twain shall meet" as the old proverb says.

CONCLUSION

Accordingly, the section 102(b) rejection of claims 1-12 and the section 103 rejection of claim 13, must be reconsidered, in the light of the foregoing amendments.

In view of the foregoing amendments and arguments, it is respectfully submitted that the claims, as amended, are clear and patentably distinguish over SAKAI+/TOSHIBA and the other art of record, taken singly or in combination. If the Examiner notes any remaining informalities, or wishes to make any suggestions to place the application in condition for allowance, a telephone call to the undersigned is invited.

Respectfully submitted,

Milton Oliver

Milton Oliver, Reg. # 28,333
TEL: 203-261-1234
FAX: 203-261-5676
CUST. # 004955

Attachment: marked-up spec. page 17 and clean copy thereof

For further explanation, the reader is referred to the even more greatly magnified depiction of FIG. 16, which shows an enlarged portion of FIG. 15. A thin land having two segments 270' and 270'' interconnected by a target region 270''', and a radial portion 272, provide mechanical retention of pole shoe 260A on magnetic yoke 200. Target region 270''' is located, as depicted, in the vicinity of pole boundary 271 with respect to the adjacent rotor pole 260D. The reason for this is that in FIG. 16, the lower of the two recesses 266A' must not be too small, so that it can be manufactured inexpensively, usually by punching. (If this recess becomes too small, it must be produced by expensive methods, e.g. by electrical discharge machining.)

In operation, segments 270' and 270'' are saturated magnetically and therefore act practically like air.

Target region 270''' is connected, via a magnetic shunt <u>or flow path element</u> 274', 274'' that extends through cavity 266A', to a source region, namely the oblique side 264A' of permanent magnet 262A, so that an additional small magnetic flux is injected from this source region 264A', through magnetic shunt 274'', 274', into target region 270'''. It has been shown that by this action, the shape of the induced voltage can be much better approximated to a sinusoidal shape. Since magnetic shunt 274', 274'' is concealed inside rotor 36', this shunt has no substantial influence on the amplitude of the cogging torque, so that optimization of the cogging torque (by modifying the width of permanent magnets 262) and optimization of the electromagnetic torque (by flux injection) are possible largely independently of one another.

FIG. 17 shows that as a result of this action, the flux distribution in air gap 39 can be better approximated to a sinusoidal shape, since a small magnetic flux is injected in the region of the interpolar gaps (of rotor 36').

FIG. 18 is a view similar to FIG. 12 but for a motor having a rotor 36' as shown in FIGS. 15 through 17. The stator corresponds to that depicted in FIG. 9 and is therefore not shown again in FIGS. 15 through 17. The designations used in FIG. 18 are the same as in FIG. 12, and the reader is therefore referred to the explanations of FIG. 12 in order to avoid repetition.

For further explanation, the reader is referred to the even more greatly magnified depiction of FIG. 16, which shows an enlarged portion of FIG. 15. A thin land having two segments 270' and 270'' interconnected by a target region 270''', and a radial portion 272, provide mechanical retention of pole shoe 260A on magnetic yoke 200. Target region 270''' is located, as depicted, in the vicinity of pole boundary 271 with respect to the adjacent rotor pole 260D. The reason for this is that in FIG. 16, the lower of the two recesses 266A' must not be too small, so that it can be manufactured inexpensively, usually by punching. (If this recess becomes too small, it must be produced by expensive methods, e.g. by electrical discharge machining.)

In operation, segments 270' and 270'' are saturated magnetically and therefore act practically like air.

Target region 270''' is connected, via a magnetic shunt or flow path element 274', 274'' that extends through cavity 266A', to a source region, namely the oblique side 264A' of permanent magnet 262A, so that an additional small magnetic flux is injected from this source region 264A', through magnetic shunt 274'', 274', into target region 270'''. It has been shown that by this action, the shape of the induced voltage can be much better approximated to a sinusoidal shape. Since magnetic shunt 274', 274'' is concealed inside rotor 36', this shunt has no substantial influence on the amplitude of the cogging torque, so that optimization of the cogging torque (by modifying the width of permanent magnets 262) and optimization of the electromagnetic torque (by flux injection) are possible largely independently of one another.

FIG. 17 shows that as a result of this action, the flux distribution in air gap 39 can be better approximated to a sinusoidal shape, since a small magnetic flux is injected in the region of the interpolar gaps (of rotor 36').

FIG. 18 is a view similar to FIG. 12 but for a motor having a rotor 36' as shown in FIGS. 15 through 17. The stator corresponds to that depicted in FIG. 9 and is therefore not shown again in FIGS. 15 through 17. The designations used in FIG. 18 are the same as in FIG. 12, and the reader is therefore referred to the explanations of FIG. 12 in order to avoid repetition.